Aspergillus flavus infection and aflatoxin contamination in peanuts stored at wholesale and retail levels in Bandung, Bogor and Jakarta (West Java, Indonesia)

Dharmaputra, O.S.*#[1], Retnowati, I.[2], Ambarwati, S.[2]
[1] SEAMEO BIOTROP, Jl. Raya Tajur Km. 6, PO Box 116, Bogor 16134, Indonesia. Email: okky@biotrop.org; okky_sd@yahoo.com
[2] Faculty of Mathematics and Natural Sciences, Bogor Agricultural University, Jl. Raya Pajajaran, Bogor, Indonesia

* Corresponding author
# Presenting author

DOI: 10.5073/jka.2010.425.167.303

Abstract

The objective of the study was to obtain information on the percentage of kernels infected by *Aspergillus flavus* and aflatoxin contents in peanuts stored at wholesale and retail levels (traditional market and supermarket) in three cities (Bandung, Bogor and Jakarta). The moisture content of the kernels were also investigated. The three cities were selected because they are different in terms of their elevations and rainfalls. A total of 105, 101, 87, 99, 104 and 98 peanut kernels were collected in March, June, September, December 2005; in March and June 2006, respectively. The moisture content of peanut kernels either collected at wholesaler or retailer in the three cities (Bandung, Bogor and Jakarta) fluctuated during sampling (between 6 – 8%). The moisture content of kernels either at the wholesaler or retailer in Bogor had the same pattern with those in Jakarta, while those in Bandung had different patterns. The moisture content of kernels either at wholesale or retail levels in the three cities were relatively similar, although the relative humidites and temperatures of the storages at wholesale and retail levels in Bandung were relatively lower than those in Bogor and Jakarta. The percentage of kernels infected by *A. flavus* in peanuts collected from wholesaler had the same pattern with those collected from retailer. The highest percentage of kernels infected by *A. flavus* either collected from wholesaler or retailer was in June 2005, while the lowest was in September 2005. The median and the highest range of percentage of kernels infected by *A. flavus* were in peanuts collected from Bandung, while the lowest were those collected from Bogor. The median and the range of percentage of kernels infected by *A. flavus* collected from wholesaler were higher than those collected from retailer. The median of aflatoxin B_1 content in peanut kernels either collected from wholesaler or retailer during sampling were relatively similar (< 20 ppb), nevertheless their broadest range was recorded in June 2005. They were correlated with the percentage of kernels infected by *A. flavus*. The highest median (± 20% of 204 samples) and the broadest range (10 – 60%) of frequency of samples contaminated with aflatoxin B_1 > 15 ppb were in samples collected from Bandung, followed by samples from Jakarta (the median ± 20% of 181 samples, the range 10 – 40%), and samples collected from Bogor (the median ± 15% of 180 samples, the range 10 – 40%). The frequency of peanut samples contaminated with aflatoxin B_1 > 15 ppb collected from retailer was higher (the median 26% of 390 samples) than those collected from wholesaler (the median 18% of 175 samples), although the median and the range of percentage of kernels infected by *A. flavus* collected from wholesaler were higher than those collected from retailer.

Keywords: *Aspergillus flavus*, Aflatoxin, Peanuts, Storage, Wholesale and retail levels.

1. Introduction

Surveys of aflatoxin B_1 contents in two peanut producing regions in Central Java (Pati and Wonogiri), and Cianjur region in West Java concluded that the majority of aflatoxin contamination of local peanuts occurred in the wholesale and retail levels, and especially in traditional markets selling raw kernels (Dharmaputra, 2003a, 2005, 2007a), despite their moisture contents being less than 8%. In Indonesia in 2009 the total production of peanuts was 785,151 Tonnes (BPS, 2009). However, Indonesia imports peanuts mostly from China, India and Vietnam, and sometimes from Thailand and Africa. BPS (2009) reported that in Indonesia in 2009, as much as 177,030 tonne of peanuts were imported from several countries. According to Dharmaputra et al. (2007b) the majority of aflatoxin contamination of imported peanuts also occurred in the wholesale and retail levels, although in general their moisture contents were also less than 8%. Moisture content of the substrate and temperature are the mains factors affecting *A. flavus* growth and aflatoxin formation. Moisture content is always in equilibrium with the

relative humidity of the storage. According to Diener and Davis (1969), and Heathcote and Hibbert (1978) the minimum and optimum moisture contents of peanuts for aflatoxin production at 30°C are 9-10% and 25%, respectively.

The objectives of the study were:

1. To obtain information on aflatoxin contamination in peanuts stored at wholesale and retail levels (traditional market and supermarket) in three cities (Bandung, Bogor and Jakarta). The moisture contents of peanut kernels and the incidence of *A. flavus* were also determined.
2. To develop an enhanced understanding of factors leading to the post-harvest build up of aflatoxin in peanuts during storage.

2. Materials and methods

2.1. Time and location of surveys

Surveys were conducted from mid-March 2005 until mid-June 2006 at selected wholesalers and retailers in Bandung, Bogor and Jakarta, West Java. The three cities were selected, because they are different in terms of their elevations and rainfalls (Table 1). The retailers included outlets at traditional markets and supermarkets.

Table 1 The elevations and rain-falls of Bandung, Bogor and Jakarta in 2003

City	Height from the sea level (m)	Rain-fall per year (mm)
Bandung	791	2200.6
Bogor	250	2387.1
Jakarta	30	1903.8

(Source: BPS 2006)

2.2. Sampling methods

Random sampling of peanut kernels consisted of either local or imported peanuts. The number of samples collected from each peanut delivery chain located in each city is presented in Table 2. A total of 105, 101, 87, 99, 104 and 98 peanut kernels were collected in March, June, September, December 2005; in March and June 2006, respectively.

Table 2 The number of peanut samples collected from each delivery chain located in each city.

Month and year of sampling	City	Number of samples			
		Wholesale	Retail at traditional market	Supermarket	Total
March 2005	Bandung	10	24	2	36
	Bogor	10	21	2	33
	Jakarta	10	24	2	36
					105
June 2005	Bandung	10	24	2	36
	Bogor	10	21	1	32
	Jakarta	10	21	2	33
					101
September 2005	Bandung	10	24	2	36
	Bogor	10	24	2	36
	Jakarta	5	9	1	15
					87
December 2005	Bandung	10	24	0	34
	Bogor	10	18	1	29
	Jakarta	10	24	2	36
					99
March 2006	Bandung	10	24	2	36
	Bogor	10	21	1	32
	Jakarta	10	24	2	36
					104
June 2006	Bandung	10	24	2	36
	Bogor	10	15	1	26
	Jakarta	10	24	2	36
					98

Each peanut sample (2 kg kernels per sample) collected from each wholesaler could be derived from one or more stacks, depending on the number of stacks available at the time of sampling. The number of bags (sacks) from a stack where the peanut samples were taken depended on the total number of bags in the stack.

Peanut samples collected from each retailer at traditional markets consisted of two qualities if possible (3 samples per quality, 2 kg kernels per sample), and those collected from each supermarket consisted of two brands if possible (2 kg kernels per brand) with the peanuts being packed in polyethylene bags. Peanut samples collected from each wholesaler, retailer and supermarket were divided three times using a box divider to obtain working samples for various analyses.

2.3. Moisture content, A. flavus and aflatoxin determination

The relative humidities and the temperatures of the storage at wholesalers and retailers at traditional markets were monitored using tiny tag data loggers at hourly intervals. Moisture contents of kernels (based on a wet basis) were analyzed using a SINAR TM AP 6060 Moisture Analyzer at the time of sampling. Two replicates were used from each sample.

The percentage of kernels infected by *A. flavus* was determined using a plating method (100 kernels per sample) on Aspergillus Flavus and Parasiticus Agar (AFPA) (Pitt et al. 1983). Aflatoxin B_1 content was determined because it is the most dangerous toxin. Aflatoxin B_1 contents in the kernels was determined using the ELISA method (Lee and Kennedy, 2002). Two replicates were used from each sample.

3. Results

3.1. Moisture content

The moisture content of peanut kernels either collected at wholesaler or retailer outlets in the three cities (Bandung, Bogor and Jakarta) fluctuated during sampling and were between 6 – 8% (Fig. 1). The moisture content of kernels either at wholesaler or retailer in Bogor had the same pattern with those in Jakarta, while those in Bandung had different patterns (Fig. 1). The moisture content of kernels at wholesaler and retailer in the three cities decreased in September 2005, except at the wholesaler in Bandung.

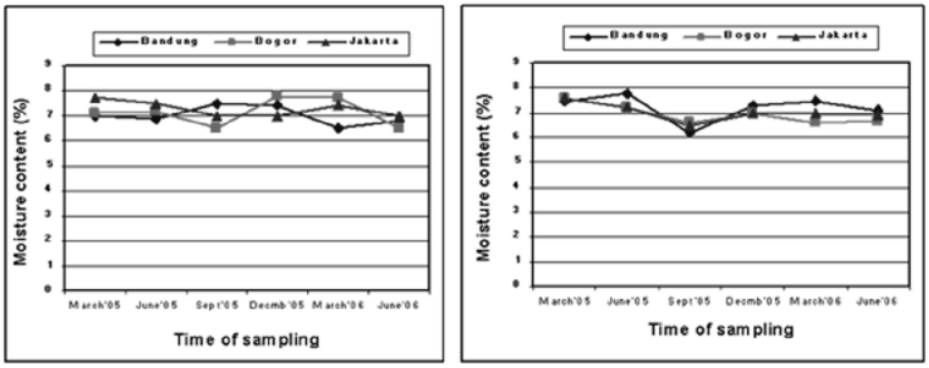

Figure 1 Moisture contents of peanut samples collected from wholesaler (a) and retailer (b) in Bandung, Bogor and Jakarta in March 2005 – June 2006

The moisture content of kernels either at wholesaler or retailer levels in the three cities were relatively similar, although the relative humidites and temperatures of the storages at wholesaler and retailer levels in Bandung were relatively lower than those in Bogor and Jakarta (Fig. 2 and 3). In general, the patterns of kernel moisture contents were relatively similar with those of relative humidites.

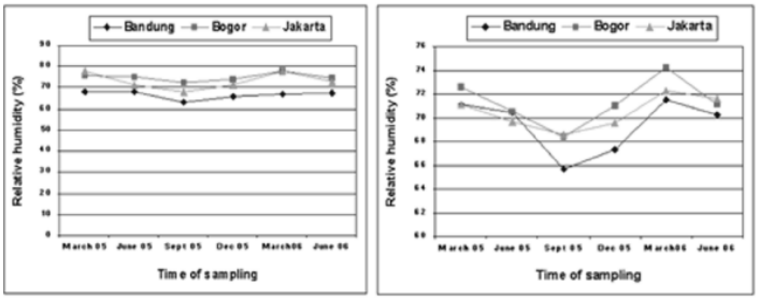

Figure 2 Relative humidity of storages at wholesale (a) and retail (b) levels in Bandung, Bogor and Jakarta in March 2005 – June 2006

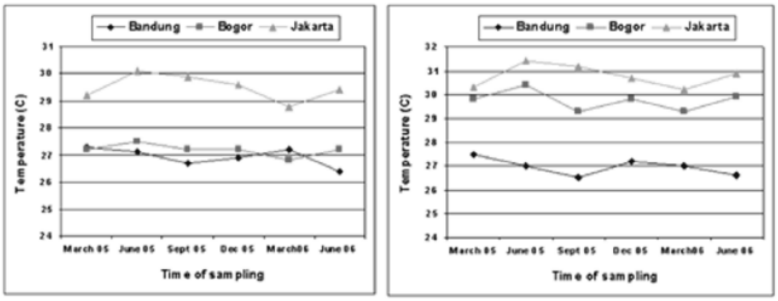

Figure 3 Temperatures of storages at wholesale (a) and retail (b) levels in Bandung, Bogor and Jakarta in March 2005 – June 2006

3.2. Aspergillus flavus infection

The percentage of kernels infected by *A. flavus* in peanuts collected from wholesaler had the same pattern as those collected from the retailers. The highest percentage of kernels infected by *A. flavus* either collected from wholesaler or retailer were in June 2005, while the lowest were in September 2005 (Fig. 4).

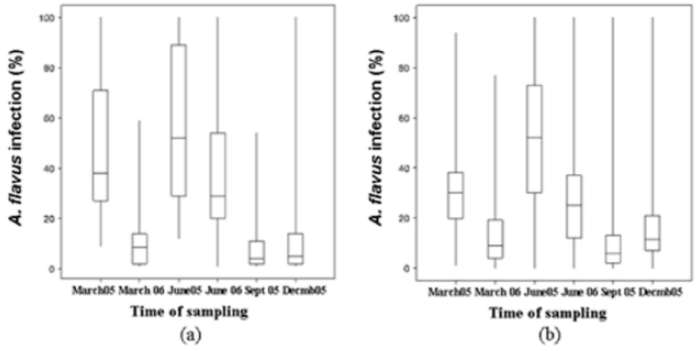

Figure 4 *Aspergillus flavus* infection in peanut samples collected from wholesaler (a) and retailer (b) in Bandung, Bogor and Jakarta in March 2005 – June 2006

The median and the highest range of percentage of kernels infected by *A. flavus* were in peanuts collected from Bandung, while the lowest were those collected from Bogor (Fig. 5). The median and the range of percentage of kernels infected by *A. flavus* collected from wholesaler were higher than those collected from retailers (Fig. 6).

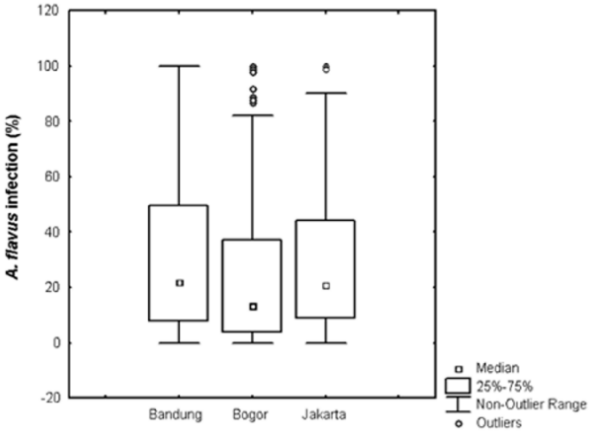

Figure 5 *Aspergillus flavus* infection in peanut samples collected from Bandung, Bogor and Jakarta in March 2005 – June 2006

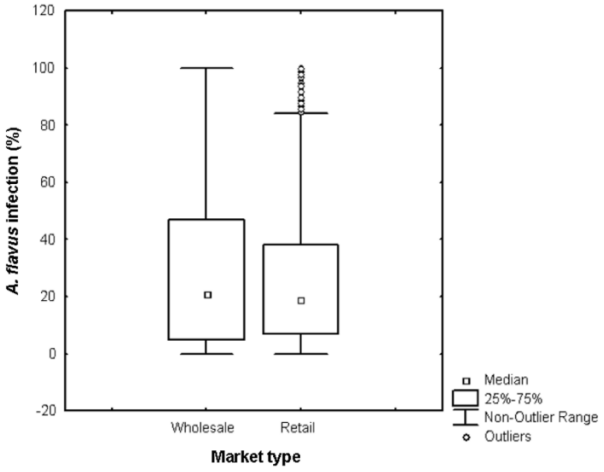

Figure 6 *Aspergillus flavus* infection in peanut samples collected from wholesaler and retailer in March 2005 – June 2006

3.3. Aflatoxin B_1 contamination

The median of aflatoxin B_1 content in peanut kernels either collected from wholesaler or retailer during sampling were relatively similar (< 20 ppb), nevertheless their broadest range occurred in June 2005 (Fig. 7). They were correlated with the percentage of kernels infected by *A. flavus* (Fig. 4).

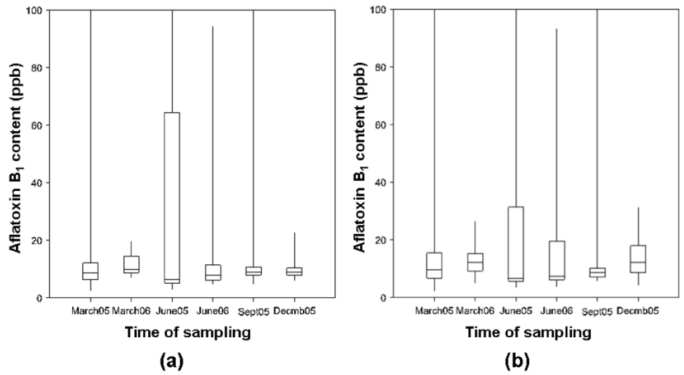

Figure 7 Aflatoxin B_1 contents in peanut samples collected from wholesaler (a) and retailer (b) in March 2005 – June 2006.

The highest median (± 20% of 204 samples) and the broadest range (10 – 60%) of frequency of samples contaminated with aflatoxin B_1 > 15 ppb were in samples collected from Bandung, followed by samples from Jakarta (the median ± 20% of 181 samples, the range 10 – 40%), and samples collected from Bogor (the median ± 15% of 180 samples, the range 10 – 40%) (Fig. 8).

The frequency of peanut samples contaminated with aflatoxin B_1 > 15 ppb collected from retailers was higher (the median 26% of 390 samples) than those collected from wholesaler (the median 18% of 175 samples) (Fig. 9), although the median and the range of percentage of kernels infected by *A. flavus* collected from wholesalers were higher than those collected from retailers (Fig. 6).

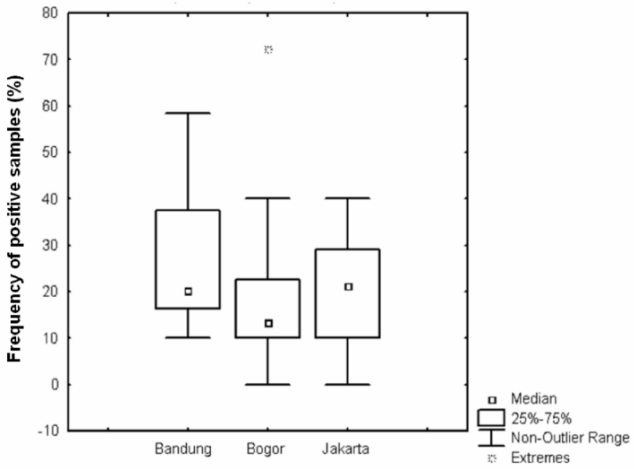

Figure 8 Frequency of aflatoxin B_1 content > 15 ppb of peanut samples collected from Bandung, Bogor and Jakarta in March 2005 – June 2006

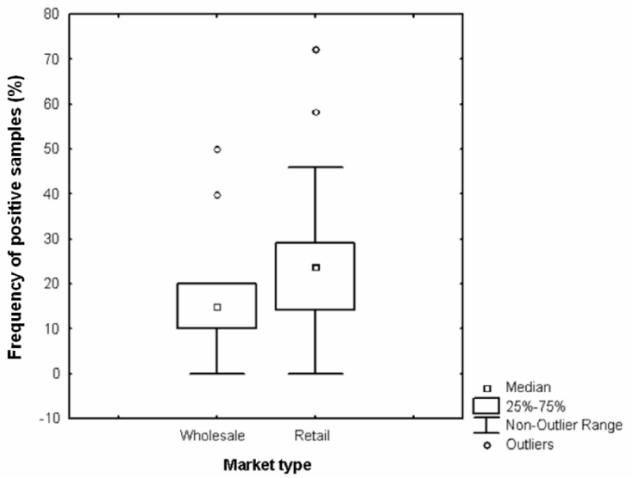

Figure 9 Frequency of aflatoxin B_1 content > 15 ppb of peanut samples collected from wholesaler and retailer in March 2005 – June 2006

4. Discussion

The moisture contentof peanut kernels collected at wholesaler or retailer in the cities (Bandung, Bogor and Jakarta) were at a safe level. According to SNI (1995) the safe moisture content for peanut kernels to be stored is around 6 – 8%. Christensen et al. (1992) stated that the moisture content of peanut kernels was in equilibrium with the relative humidity of the storage. Bala (1997) reported that the moisture content was also affected by the temperature of the storage.

The percentage of kernels infected by *A. flavus* is affected by the moisture content of the kernels, while the later is affected by the relative humidity of the storage. Relative humidity is related to the location of city from sea level as well as the month of the year. Post-harvest handling methods from farmer up to retailer levels also affect the degree of *A. flavus* infection. Antagonistic fungi can inhibit aflatoxigenic *A. flavus* growth, consequently aflatoxin production will also inhibited. Dharmaputra et al. (2001) reported that *in vitro A. niger* inhibited aflatoxigenic *A. flavus*, consequently aflatoxin production was also inhibited up to 80%. According to Pitt and Hocking (2009) aflatoxin was produced by certain strains of *A. flavus.* Dharmaputra et al. (2003b) reported that during the wet and dry seasons in 2003, 54% and 58% of 113 and 90 isolates of *A. flavus*, respectively, which were found in the soils of peanut farms in Wonogiri regency, produced aflatoxins.

5. Conclusions

- *A. flavus* infection and aflatoxin B_1 content in peanuts collected from wholesalers had the same pattern as those collected from retailers. They also correlated with the time of sampling.
- Aflatoxin B_1 content in peanut kernels either collected either from wholesalers or retailers during sampling were relatively similar (< 20 ppb), nevertheless their broadest range occurred during June 2005. Aflatoxin content was correlated with the percentage of kernels infected by *A. flavus*.
- The highest frequency of samples contaminated with aflatoxin B_1 > 15 ppb was collected from samples at Bandung, followed by samples from Jakarta and then Bogor. The frequency of peanut samples contaminated with aflatoxin B_1 > 15 ppb collected from retailers was higher than those collected from wholesalers.

Acknowledgements

The authors gratefully acknowledge the financial support of the Australian Centre for International Agricultural Research (ACIAR). Thanks are due to Drs. Graeme C. Wright, Rao C.N. Rachaputi and Agustina A. Rahmianna; to Drs. Ivan R. Kennedy and Nanju Alice Lee; and to the wholesalers and retailers in Bandung, Bogor and Jakarta, for their cooperation; to Mrs. Erita Maysra, Messrs. Suradi and Edi Suryadi of the laboratory of Microbiology, SEAMEO BIOTROP for assisting the research.

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